

**Hybrid Wind Stress Anomalies and Their Impacts  
on the Global HYCOM Simulations ?**

**By**

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## **MOTIVATION**

- **0.72° Global HYCOM**
  - **Climatologically–forced simulations**
  - **ECMWF wind stress anomalies for various periods**
- **Impact of different anomaly periods on global simulations**
  - **Sea surface temperature (SST)**
  - **Mixed layer depth (MLD)**
  - **For Atlantic only and global ocean:**
    - **Depth of max. of overturning streamfunction**
    - **Max. transport of overturning streamfunction**

## **WIND STRESS ANOMALIES**

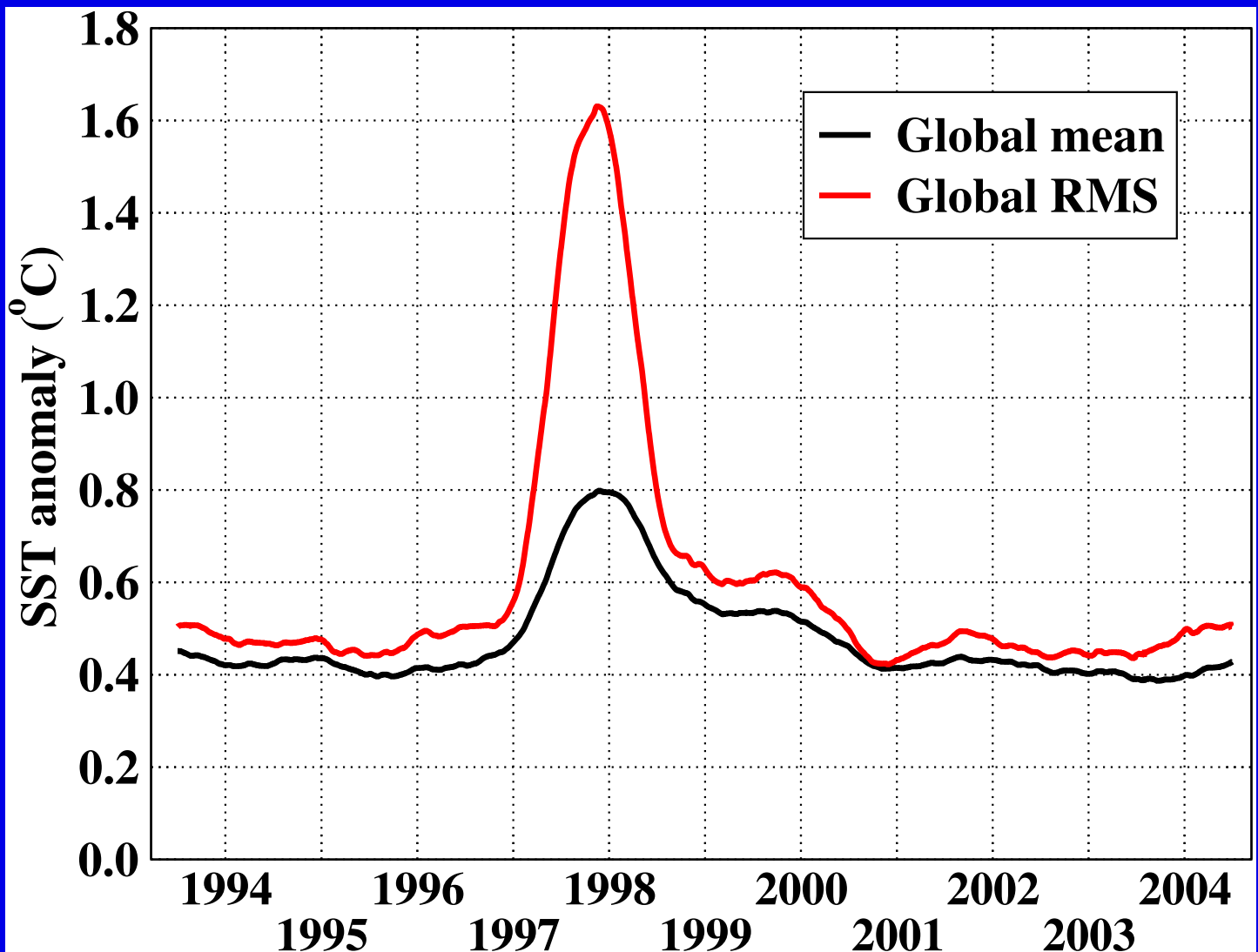
- We would like to use a time period,
- representing a **climatological normal year**:
- For historical reasons HYCOM used: Sep94–Sep95
- Other candidate time periods
  - Sep95–Sep96
  - Apr97–Apr98
  - Jan98–Jan99
  - Aug00–Aug01
  - Aug01–Aug02

**The question is:**

Which time interval for wind stress anomalies  
is appropriate for realistic HYCOM simulations?

First, why did we choose those time periods above?

## SST ANOMALY OVER THE GLOBAL OCEAN



- Use daily MODAS SSTs from 1993 through 2004
- Form daily anomalies (Interannual- Climatology)
- Calculate square of anomaly fields
- Apply 1-year running average

Note that we also selected the 1997–98 ENSO period.

## **A MOVIE FOR WIND ANOMALIES**

- **Use ECMWF wind stresses**
- **6 hourly anomalies added to monthly means**
- **This is done for each time period**
- **A movie of wind speed**
  - **at each 6 hour time intervals**

## **GLOBAL HYCOM DESCRIPTION**

- **0.72° fully global model**
  - 0.36° near equator
  - Arctic bipolar patch
- **26–layer HYBRID**
- **Initialization: Navy GDEM3 T/S climatology**
- **Monthly river discharge from NRL database**
- **Sea surface salinity relaxation to monthly PHC**

PHC: Polar science center Hydrographic Climatology

### **Atmospheric forcing is from ERA–15**

- **Bulk formulation for sensible and latent heat fluxes**
- **Shortwave and longwave radiation from ERA–15**
- **Water turbidity based on SeaWiFS ocean color data**

## **HYCOM SIMULATIONS**

- Use KPP mixed layer model
- Perform climatologically–forced simulations

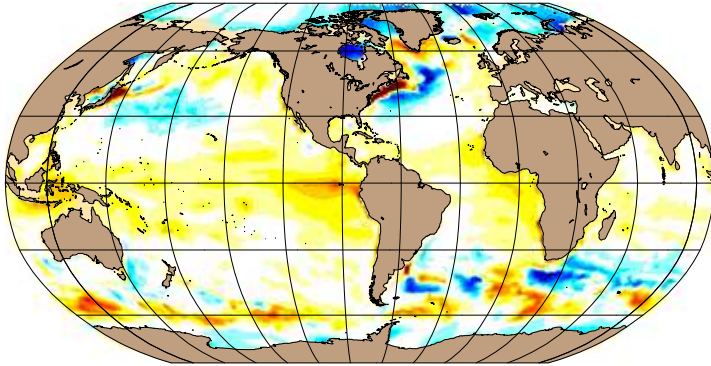
**There is NO data assimilation or relaxation to SST climatology**

- All simulations are identical except wind anomalies

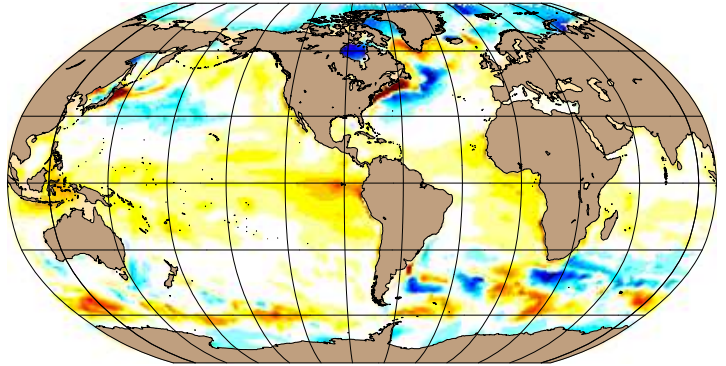


# ANNUAL MEAN HYCOM SST BIAS

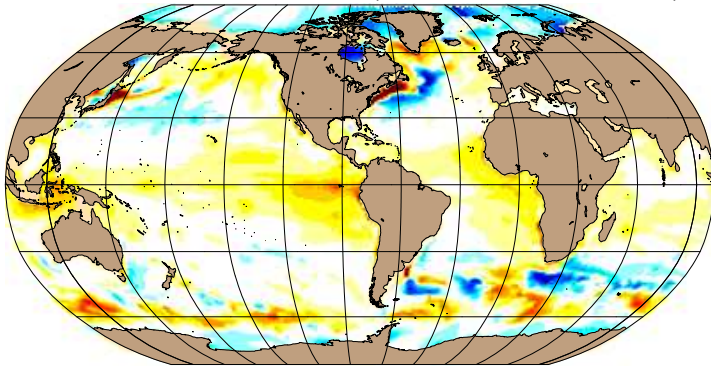
Sep94–Sep95 (BIAS = 0.4°C)



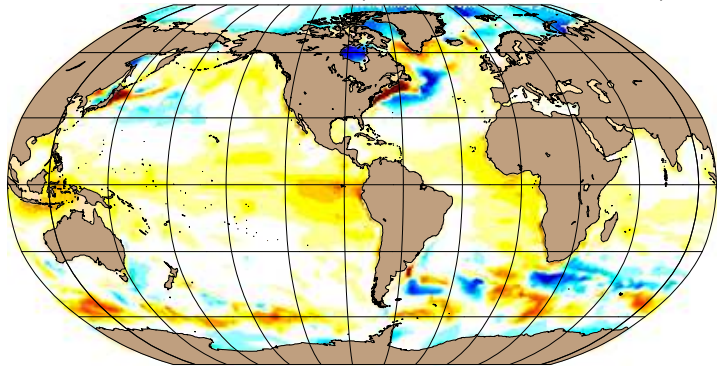
Feb95–Feb96 (BIAS = 0.4°C)



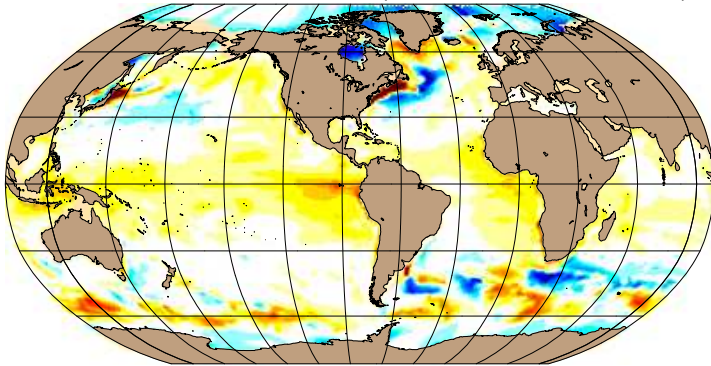
Apr97–Apr98 (BIAS = 0.4°C)



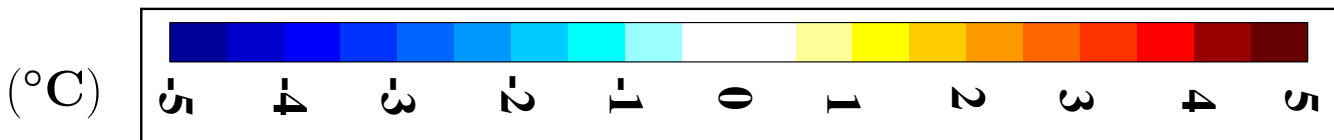
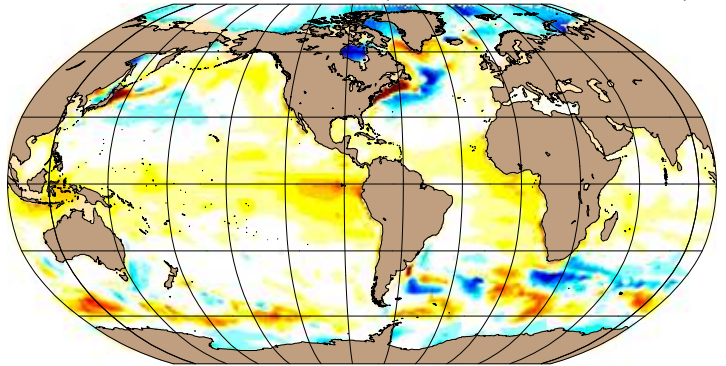
Jan98–Jan99 (BIAS = 0.4°C)



Aug00–Aug01 (BIAS = 0.4°C)



Aug01–Aug02 (BIAS = 0.4°C)

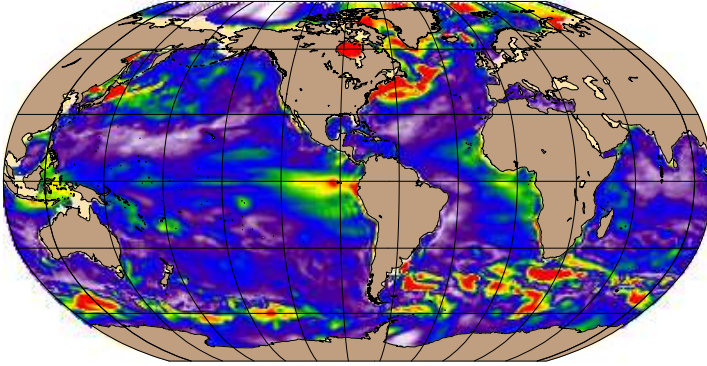


**HYCOM bias is with respect to NOAA SST climatology**

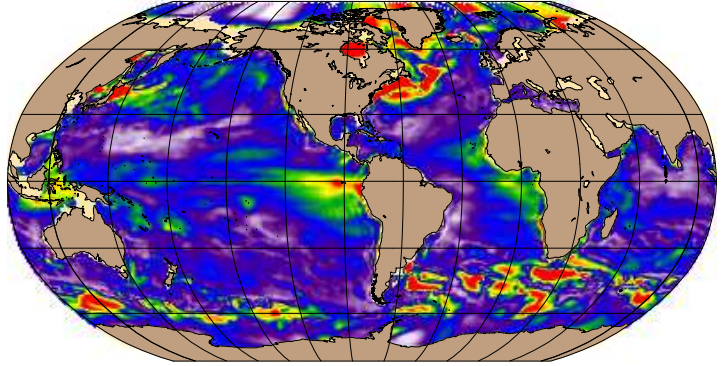


# **RMS DIFFERENCE: HYCOM vs NOAA SST**

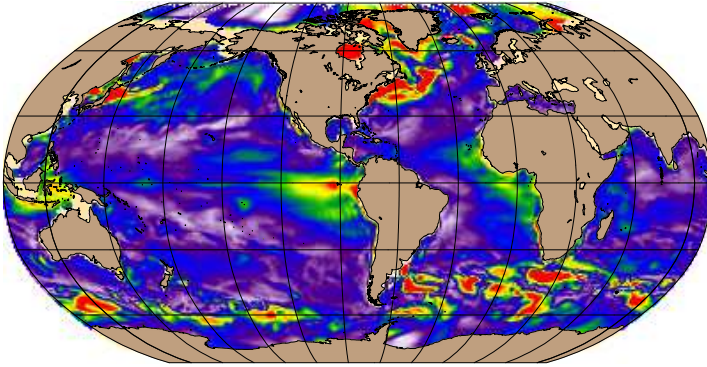
Sep94–Sep95 (RMS = 0.9°C)



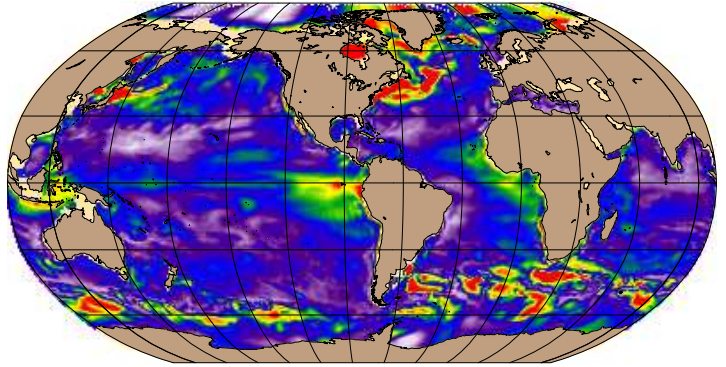
Feb95–Feb96 (RMS = 0.9°C)



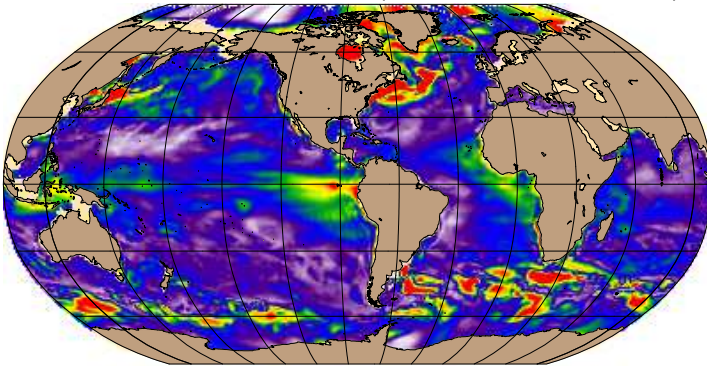
Apr97–Apr98 (RMS = 0.9°C)



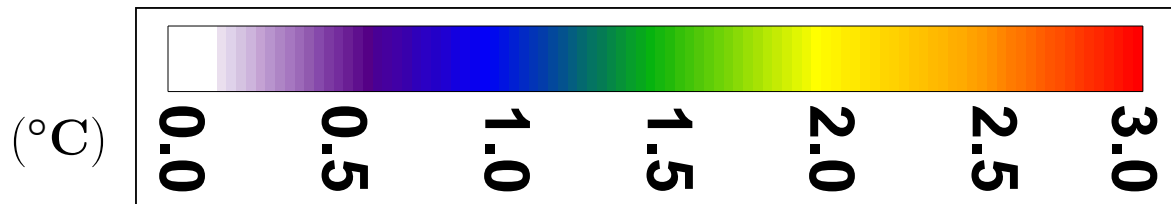
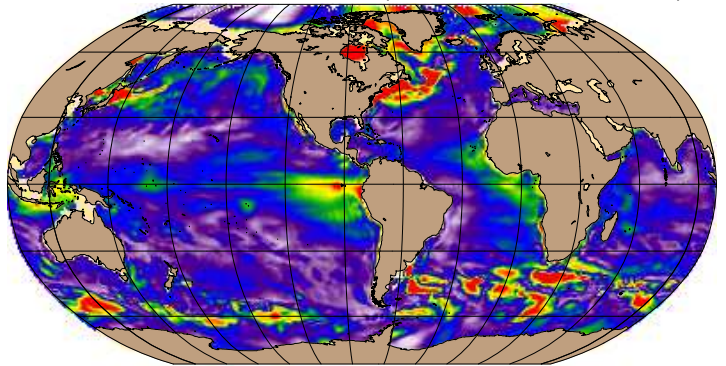
Jan98–Jan99 (RMS = 0.9°C)



Aug00–Aug01 (RMS = 0.9°C)



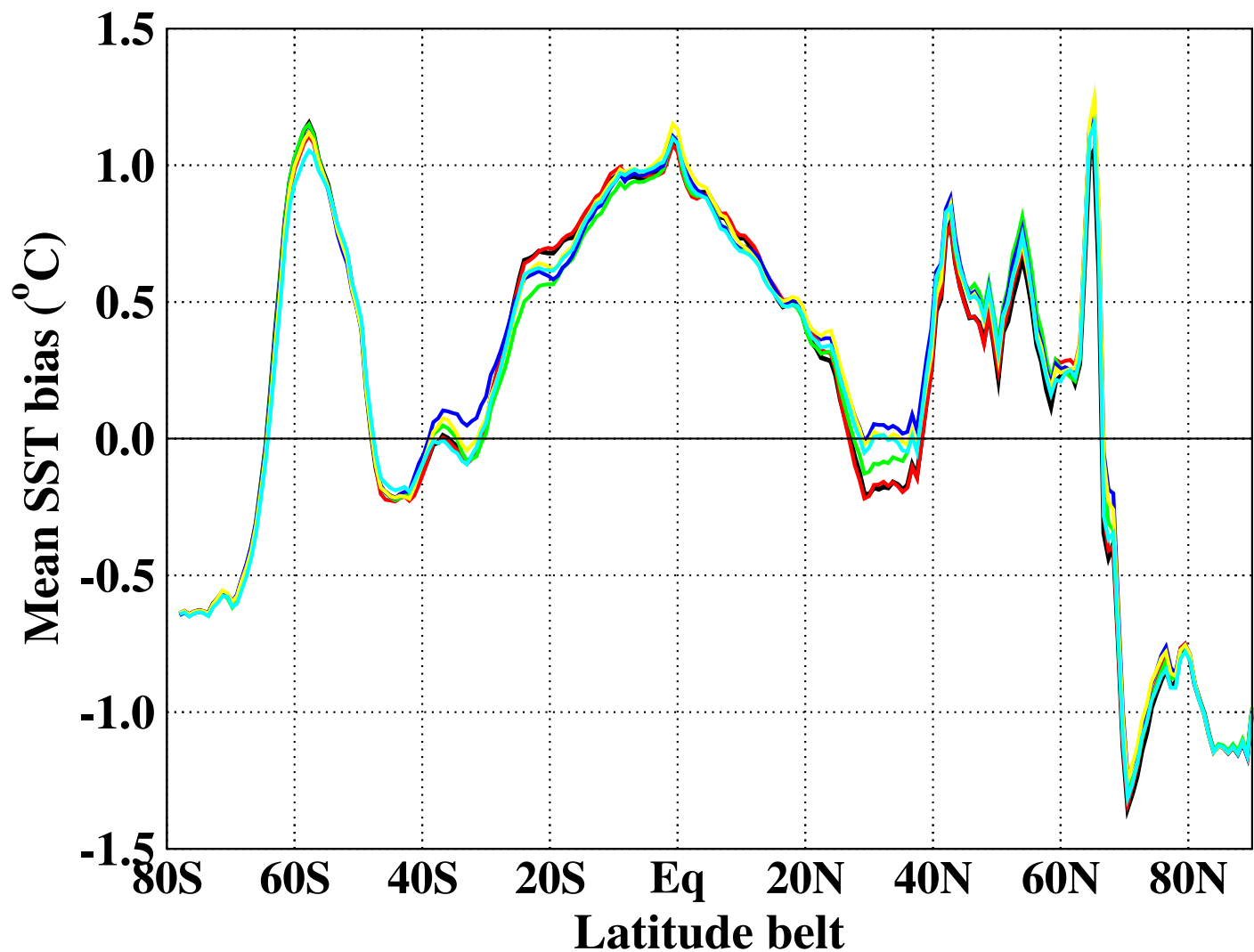
Aug01–Aug02 (RMS = 0.9°C)



**RMS is calculated over the seasonal cycle**

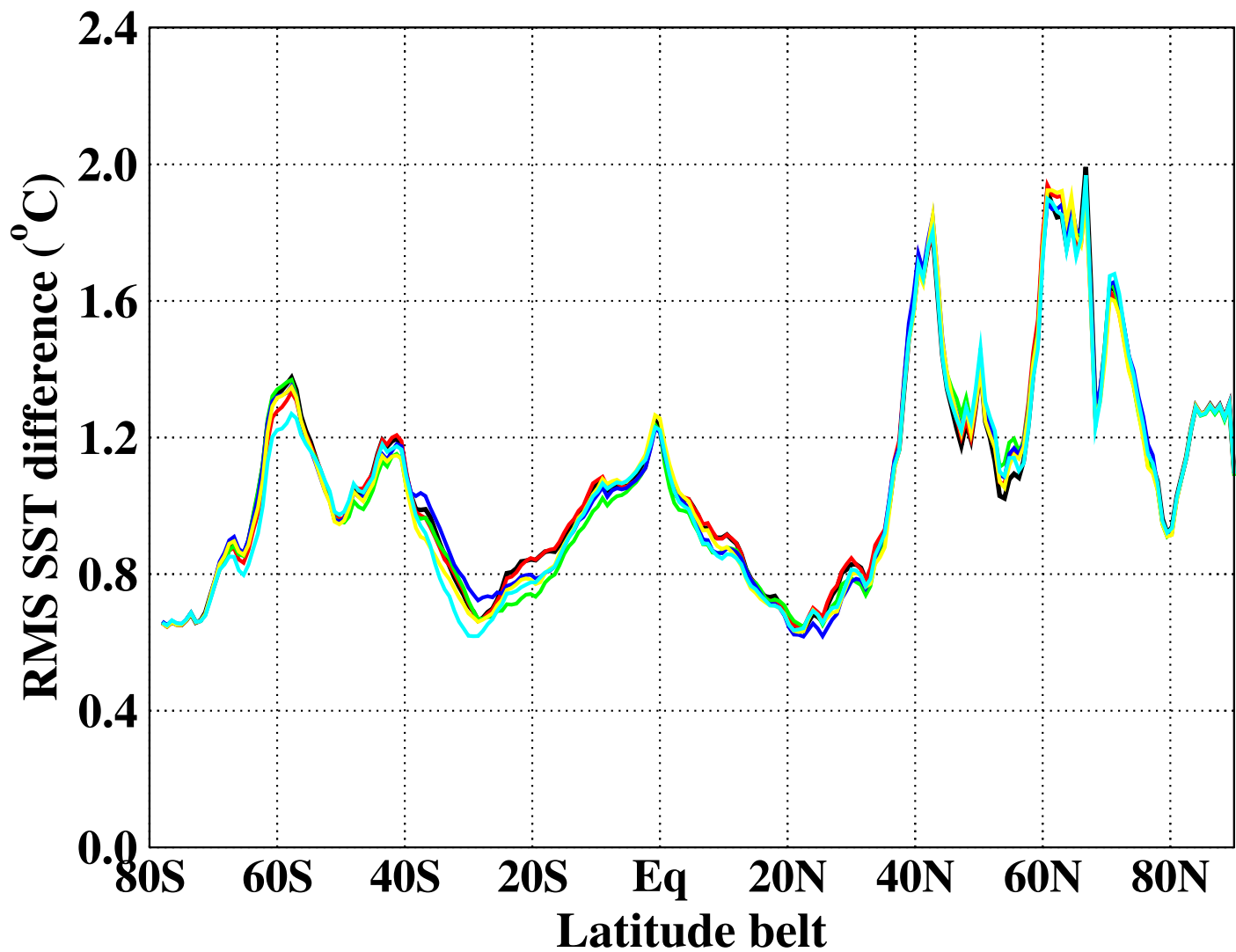
## ZONAL AVERAGES FOR SST BIAS

- (1): *standard simulation: Sep94 - Sep95*
- (2): twin of (1) but Sep95 - Sep96
- (3): twin of (1) but Apr97 - Apr98
- (4): twin of (1) but Jan98 - Jan99
- (5): twin of (1) but Aug00 - Aug01
- (6): twin of (1) but Aug01 - Aug02

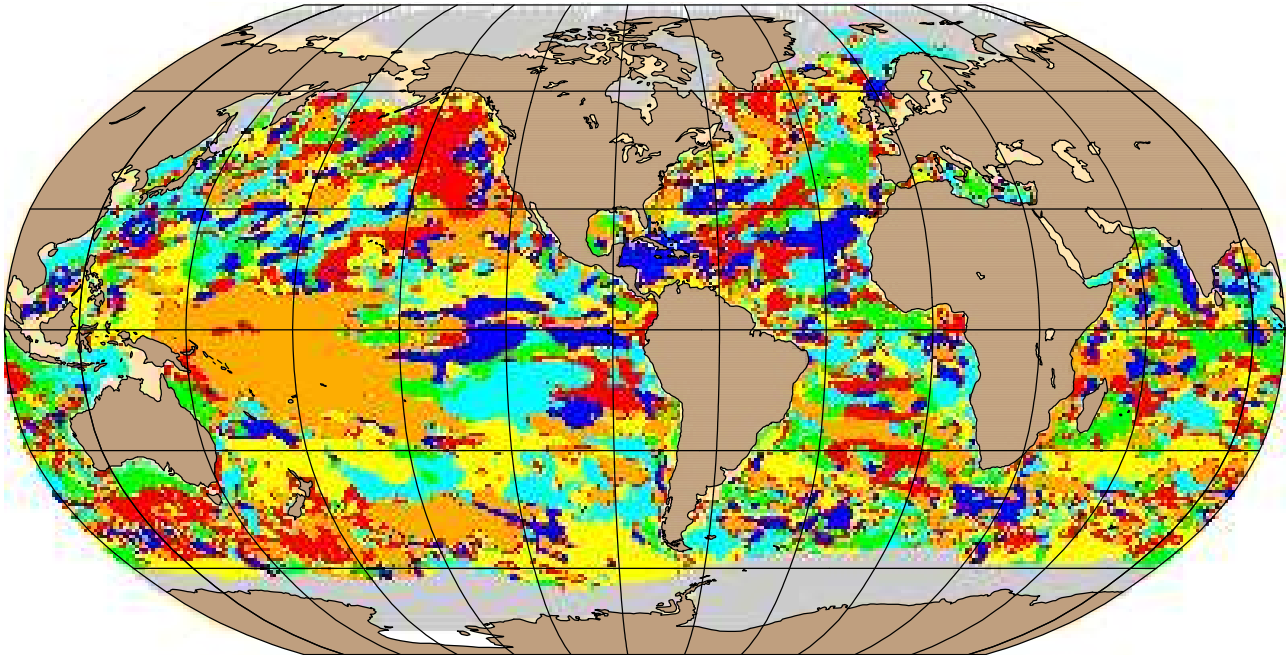


## ZONAL AVERAGES FOR RMS DIFFERENCES

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- (2): **twin of (1) but Sep95 - Sep96**
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- (4): **twin of (1) but Jan98 - Jan99**
- (5): **twin of (1) but Aug00 - Aug01**
- (6): **twin of (1) but Aug01 - Aug02**



## LOWEST RMS SST DIFFERENCES



**Feb95-96**

**Aug00-01**

**Aug01-02**

**Sep94-95**

**Apr97-98**

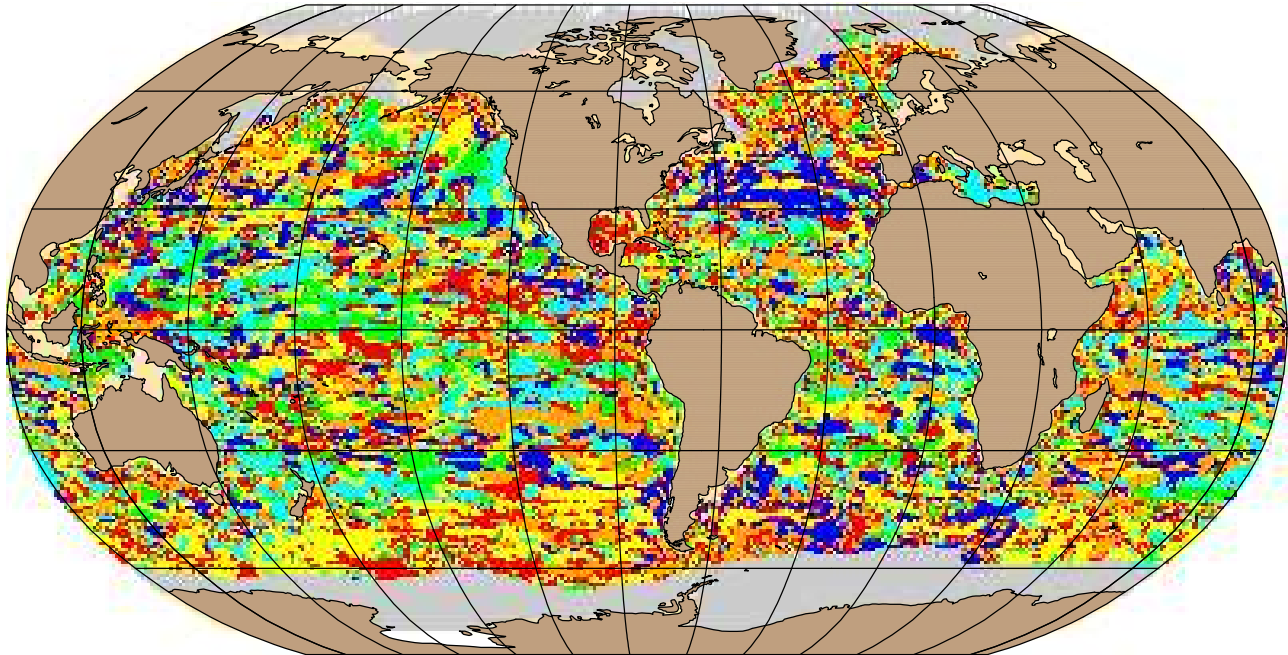
**Jan98-99**

**Percentage of global ocean coverage:**

<b>Anomaly</b>	<b>Percentage</b>	<b>Rank</b>
<b>Sep94–95</b>	<b>14.2%</b>	<b>4</b>
<b>Feb95–96</b>	<b>12.1%</b>	<b>6</b>
<b>Apr97–98</b>	<b>22.6%</b>	<b>1!!</b>
<b>Jan98–99</b>	<b>13.7%</b>	<b>5</b>
<b>Aug00–01</b>	<b>17.9%</b>	<b>3</b>
<b>Aug01–02</b>	<b>19.5%</b>	<b>2</b>



# LOWEST RMS MIXED LAYER DEPTH DIFFERENCES

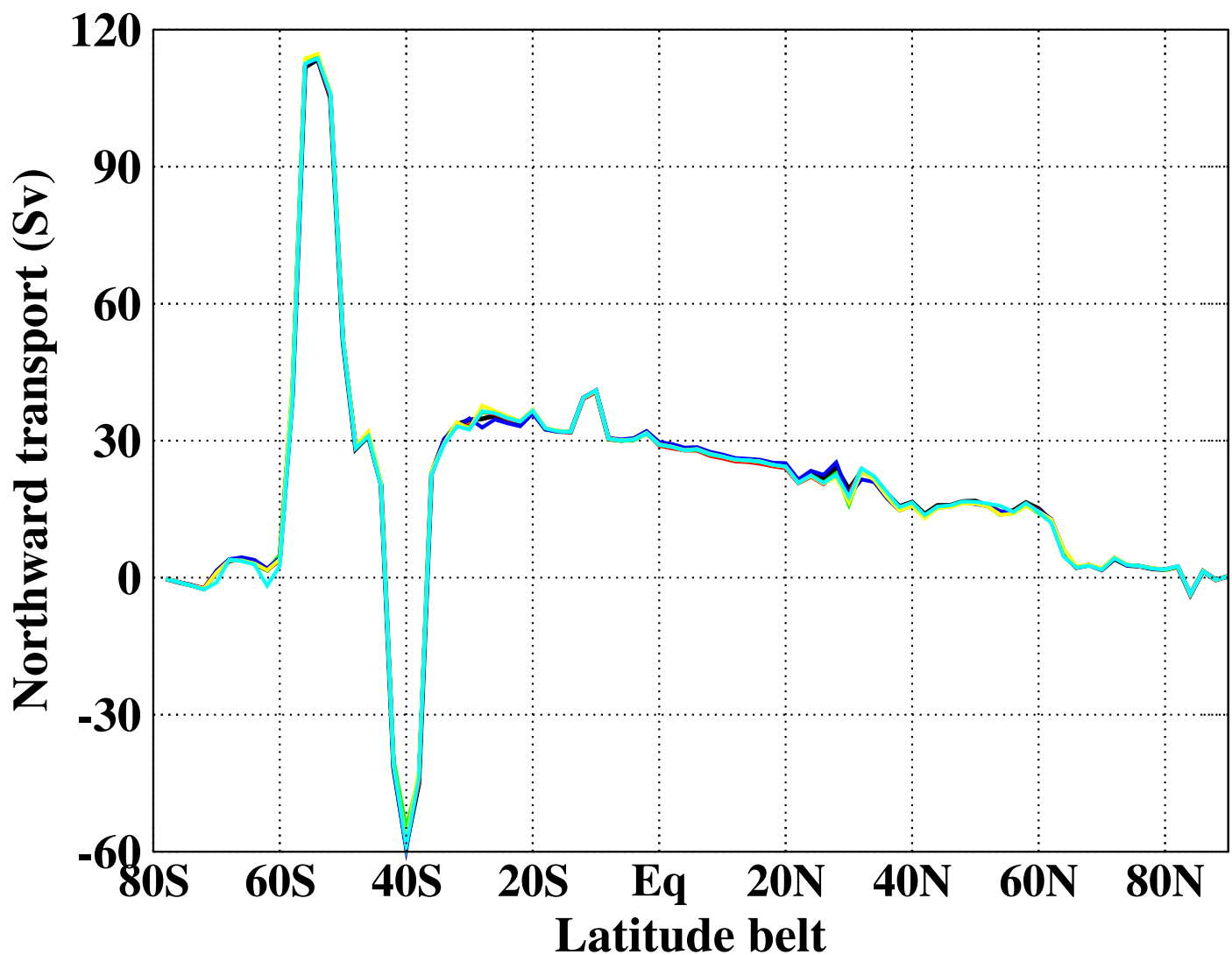


Percentage of global ocean coverage:

Anomaly	Percentage	Rank
Sep94–95	12.3%	6
Feb95–96	13.5%	5
Apr97–98	17.3%	4
Jan98–99	17.7%	3
Aug00–01	19.0%	2
Aug01–02	20.2%	1

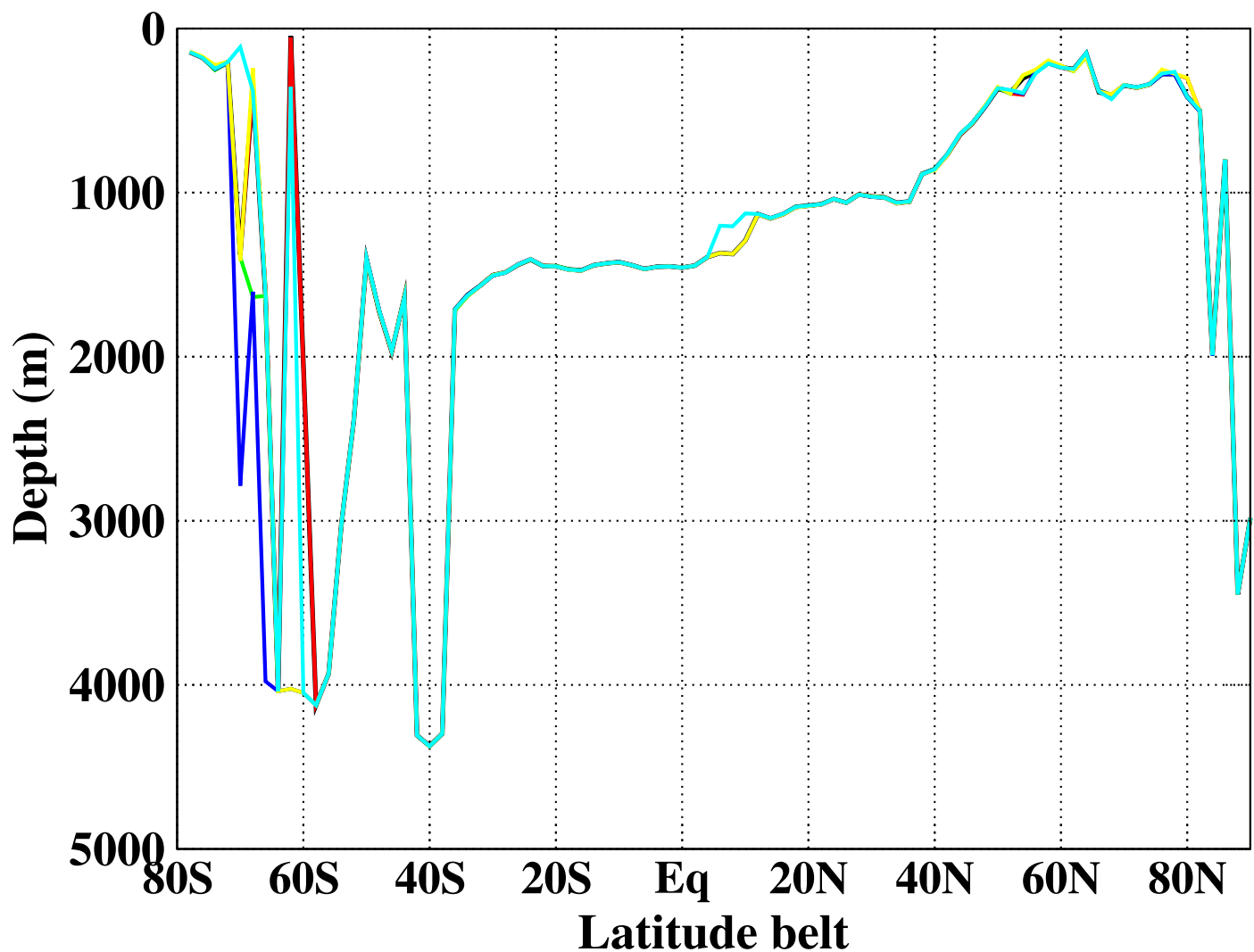
## MAXIMUM OF ATLANTIC OVERTURNING

- (1): *standard simulation: Sep94 - Sep95*
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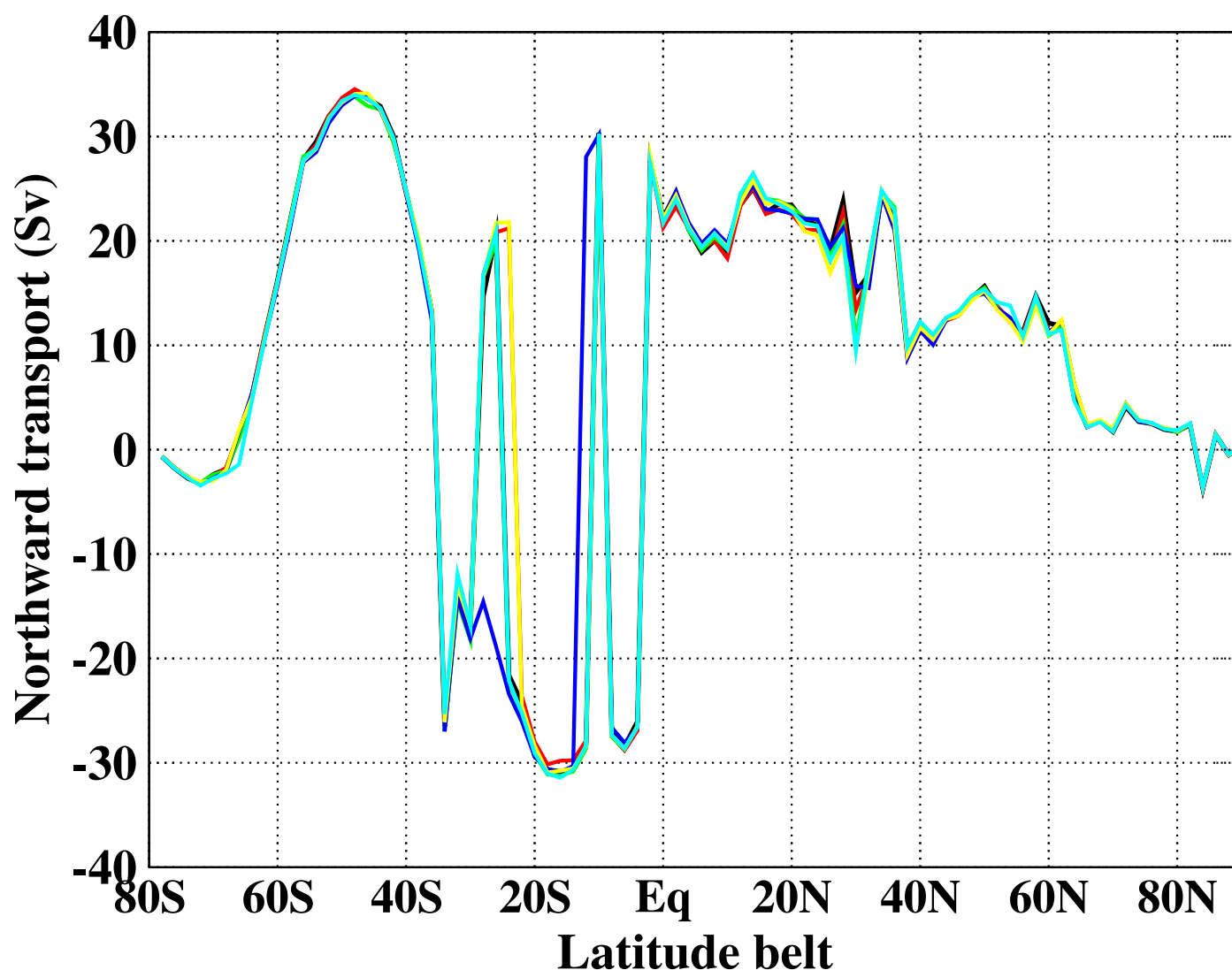
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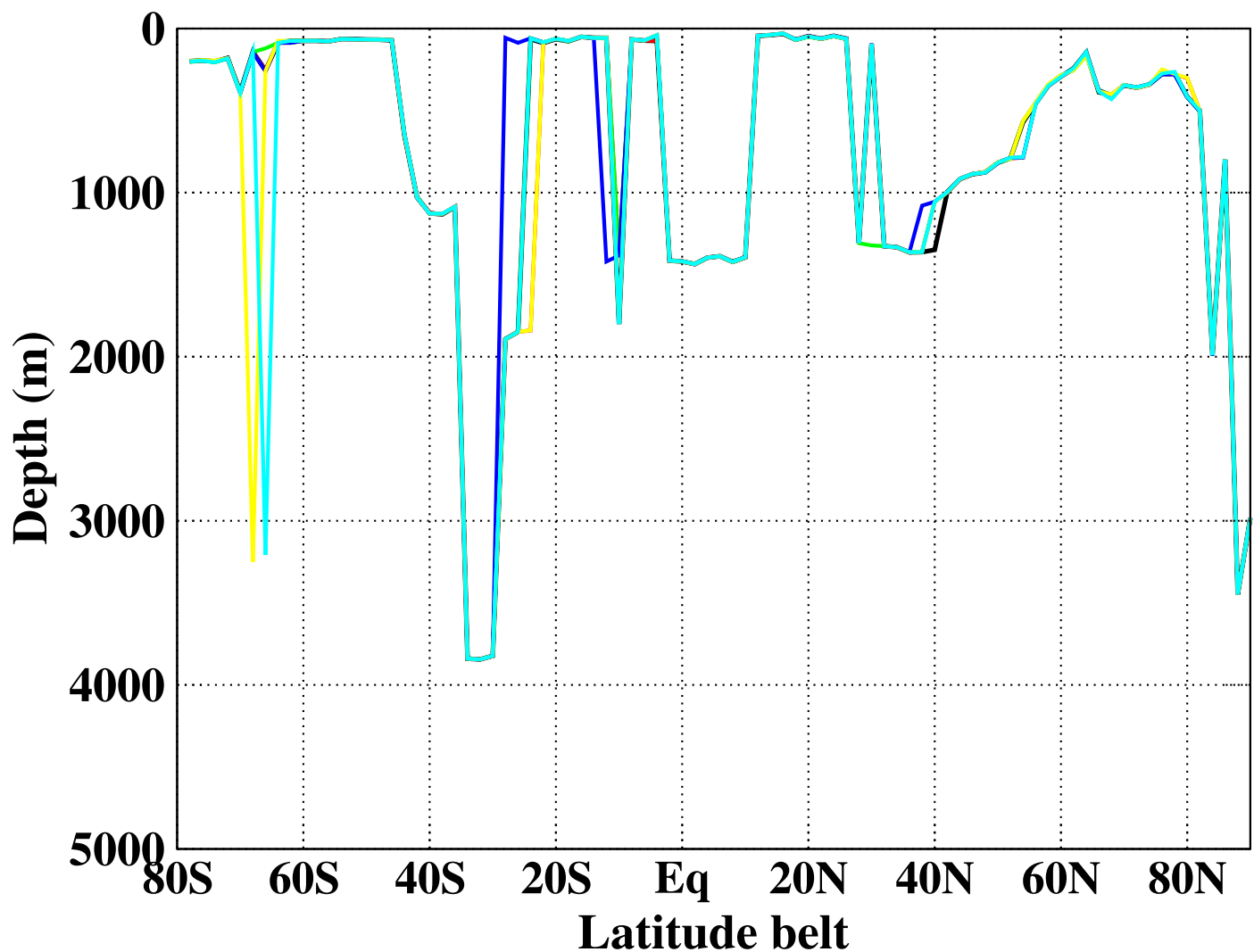
## MAXIMUM OF GLOBAL OVERTURNING

- (1): *standard simulation: Sep94 - Sep95*
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- (6): *twin of (1) but Aug01 - Aug02*



## **CONCLUSION**

- **Any anomaly time period can be used**
- **No significant change is noted in the HYCOM results**
  - **(1) climatological means of SST and MLD**
  - **(2) northward transport**
  - **(3) depth of overturning streamfunction**
- **However, we typically use snapshots for a daily output**
- **The period could be important for 3 hourly model analysis**
- **HYCOM now uses 6–hrly anomalies from NOGAPS in 2003**